THE WEATHER AND CIRCULATION OF JANUARY 1961*

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1. INTRODUCTION

In the eastern half of the United States the first half of January 1961 was relatively mild under high index circulation, continuing a warming trend which had started late in December [1]. During the second half of January, on the other hand, extremely cold weather prevailed in strong northerly flow between an intense trough along the east coast and a blocking High over western Canada; the cold spell lasted well into February. The highlight of the change in regime was a severe storm on January 19 and 20, 1961, which caused heavy snow in major cities along the east coast from Washington, D.C. to Boston, Mass. Severe blizzard conditions were reported in southern New England where northeasterly gales caused extensive flooding of coastal lowlands.

At no time during the month was the circulation favorable for extensive precipitation over most of the interior of the contiguous United States. This was the driest January in 90 years or more at several stations listed in table 1.

2. TRANSITION WITHIN THE MONTH

Many features of the interesting evolution of the mean circulation can be seen in the charts of 5-day mean 700-mb. height and weekly surface temperature anomalies, figures 1 through 4. During the first week the mean circulation (January 3–7, fig. 1A) consisted of a deep trough from Alaska southward, a rather strong ridge over the northwestern States, and a trough along the east coast of North America from Labrador to Florida. A blocking ridge in the Greenland area, with largest height anomaly in Davis Strait, was joined to the subtropical Atlantic ridge, and a strong cyclonic center was located over the North Sea. The zonal index (not shown) was diminishing slowly from the early January peak which terminated the index cycle of December [1]. However the warming trend noted at the end of December over the contiguous United States continued, and temperatures over half or more of the country averaged above normal (fig. 1B).

TABLE 1.—*Stations reporting long-standing records for least January precipitation broken in 1961*

Station	Date records began
Grand Junction, Colo.	1892
Detroit, Mich.	1871
Escanaba, Mich.	1871
Duluth, Minn.	1871
Rochester, Minn.	1886
Kansas City, Mo.*	1888
Akron, Ohio	1887
Sandusky, Ohio	1877
Toledo, Ohio	1870
Chattanooga, Tenn.	1879

*Equaled record.

By the middle of the second week (January 10–14, fig. 2A), the low center south of Alaska had intensified, while a blocking surge (best seen in the height anomaly pattern) had moved southwestward from Davis Strait to the Great Lakes. A weak trough over the Central Plains moved slowly eastward, and the trough in the western Atlantic grew stronger in the north. While zonal index values continued to diminish slowly, they remained above normal.

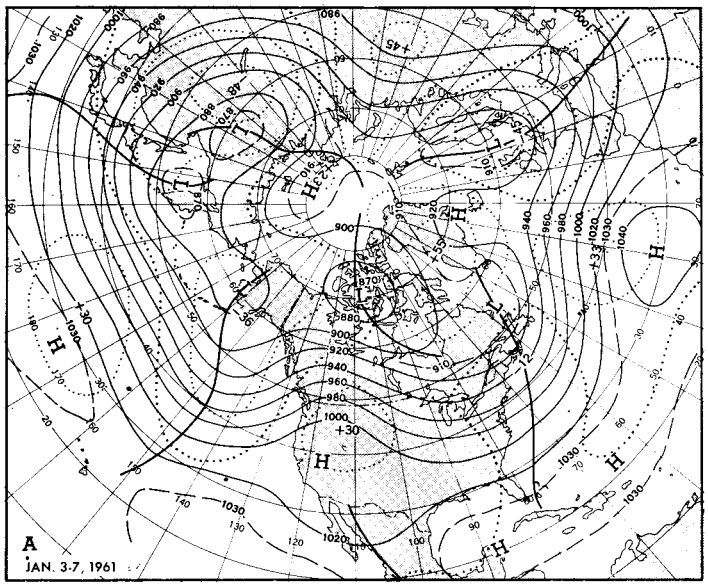
This was the warmest week of the month over most of the Nation (fig. 2B). Temperatures averaged above normal over almost the entire country, averaging 10° to 25° above in the north central interior.

One major storm during the week was responsible for moderate to heavy snow from West Virginia to southern New England. Part of this storm intensified off the middle Atlantic coast, causing hurricane-force winds and high seas off the New England coast.

Rapid amplification occurred from the central Pacific to eastern North America during the third week. Midway through the week, the Pacific cyclone reached its greatest intensity (over 1000 ft. below normal, fig. 3A). In the ridge downstream, heights averaged some 800 feet above normal in western Canada. With the Atlantic coastal trough also strong, the flow over central and eastern Canada was meridional, and cold air flowed into the eastern United States.

These conditions accompanied the severe storm of the 19th, which deepened more than 1 mb. per hour for 24 hours over the relatively warm water along the Atlantic coast. This development in turn sustained and intensified the meridional flow, so that the warm temperature regime of previous weeks was effectively ended in the East. New record low temperatures for January 21 and 22 were established in the wake of the storm at New

*Articles describing the weather of February, March, and April 1961 will appear in the May, June, and July 1961 issues, respectively.



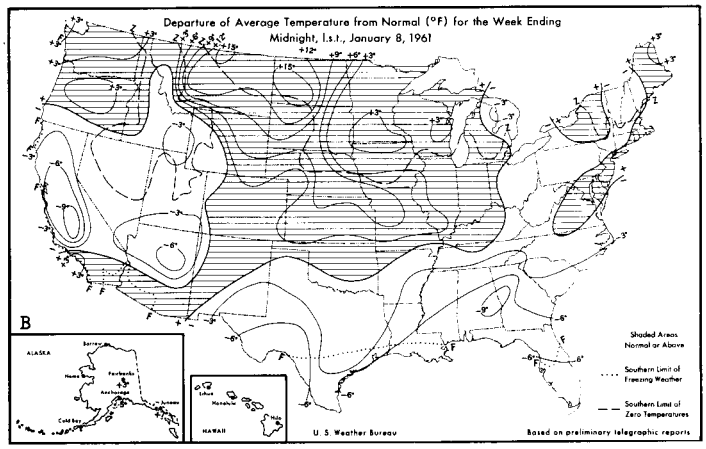
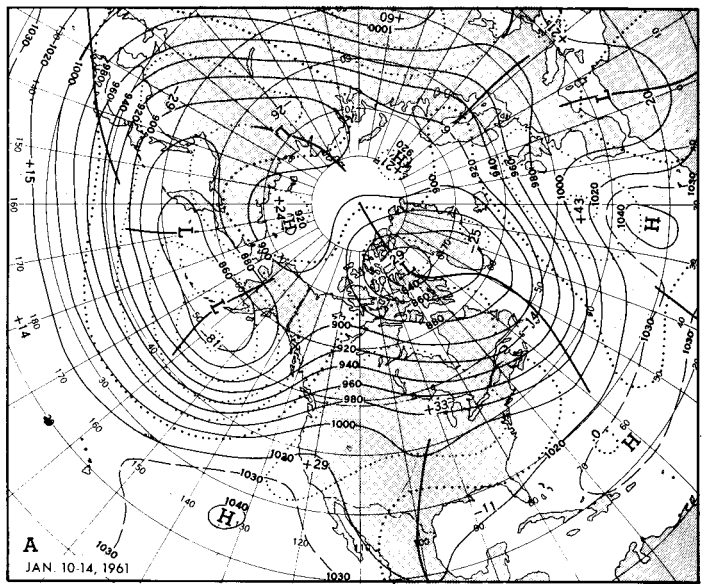


FIGURE 1—(A) 5-day mean 700-mb. heights (solid) and departures from normal (dotted), both in tens of feet, for January 3–7, 1961. This represents the mean circulation during the first week of January. Note the positive anomaly center over Davis Strait, indicating the presence of blocking. (B) Departure of average temperature from normal (°F.) for the week ending January 8. Continuation of warming from the previous week was the general rule, except in the South (from [6]).



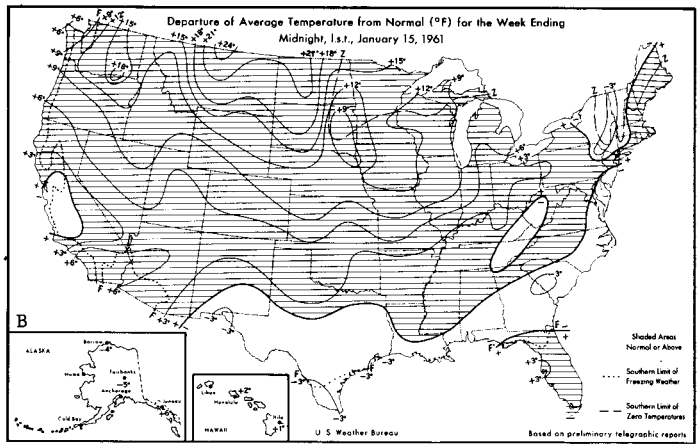
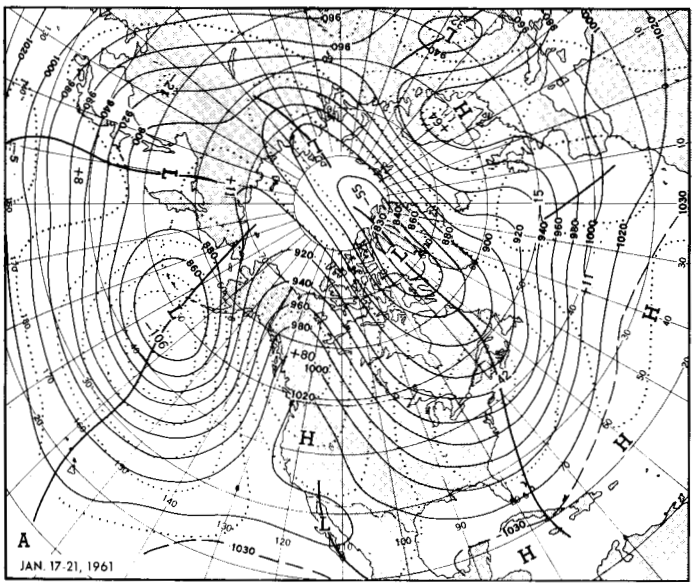


FIGURE 2.—(A) 5-day mean 700-mb. heights (solid) and departures from normal (dotted), both in tens of feet, for January 10–14, 1961. By this time a positive anomaly center had retrograded from Davis Strait to the Great Lakes region, and the negative anomaly center south of Alaska had intensified from the previous week. (B) Departure from normal of average temperature (°F.) for the week ending January 15, 1961. This was the warmest week in January (from [6]).

Haven, Conn., Wilmington, Del., Philadelphia, Pa., and for the 22d at Hartford, Conn., Chattanooga, Tenn. and Daytona Beach, Fla. Snowfall ranged from 2 to 16 inches in Maryland, 10 to 30 inches in New Jersey, and 10 to 20 inches over southern New England.

Intense cold dominated the weather east of the Continental Divide during the final week. The long-wave pattern over North America (fig. 4A) remained strongly amplified, and northerly winds continued to transport frigid air into the United States. Sub-zero minima were reported southward as far as Denver, Colo., St. Louis, Mo., Nashville, Tenn., and Richmond, Va. In the South, only Brownsville, Tex., and southern Florida escaped freezing temperatures. Most of the snow cover over the Northeast remained from the previous week, and additional snow accumulated during a final storm which intensified off the Atlantic coast on the 27th.

Comparison of half-month mean charts at 700 mb. in figure 5 reveals the remarkable change in circulation which occurred from the central Pacific to the east coast of North America during the month. Contrast between the relatively zonal pattern of the first half (part A), and the strongly amplified pattern of the second half (part B) was greatest in the Yukon. Positive height changes there (part C) were as much as 800 feet, while changes in the opposite sense were about half this magnitude in the troughs south of the Aleutians and over the Great Lakes. Changes of 700-mb. height anomaly were in the direction



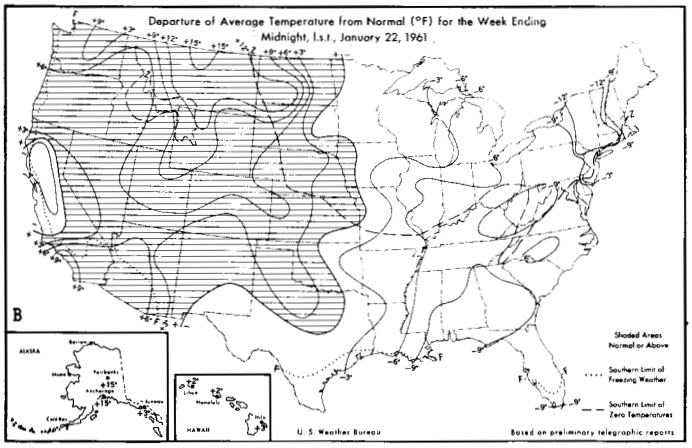
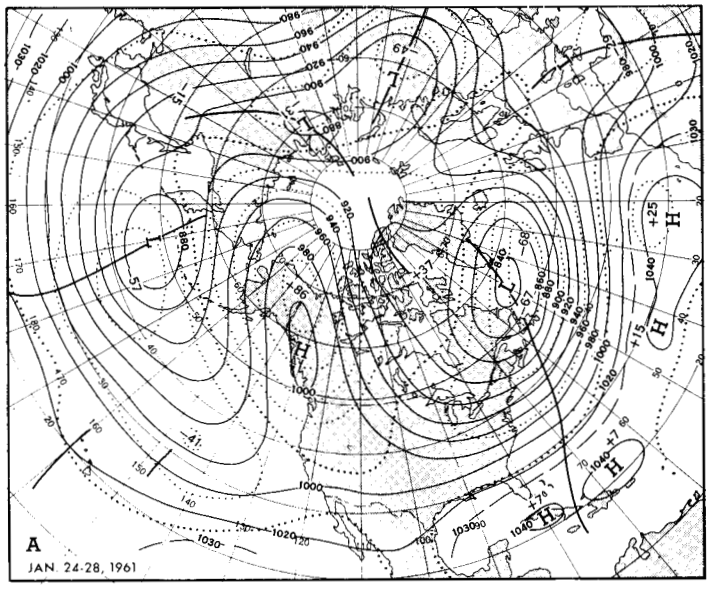


FIGURE 3.—(A) 5-day mean 700-mb. heights (solid) and departures from normal (dotted), both in tens of feet, for January 17–21, 1961. By this time the mean wave was strongly amplified from the eastern Pacific to the western Atlantic. An intense storm developed off the middle Atlantic coast this week and temperatures tumbled in the East as shown in (B) Departure from normal of average temperature (°F.) for the week ending January 22, 1961. Most of the cooling occurred after mid-week (from [6]).



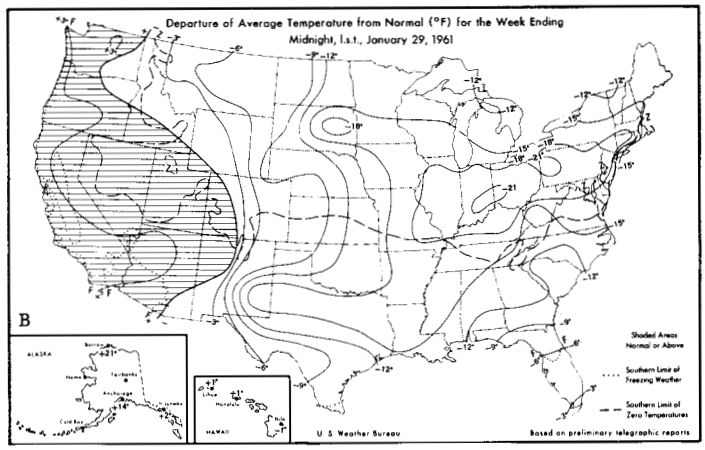


FIGURE 4.—(A) 5-day mean 700-mb. heights (solid) and departures from normal (dotted), both in tens of feet, for January 24–28, 1961. Large amplitude of the circulation continued from the previous week over North America. Cold air flooded the United States eastward from the Continental Divide. (B) Departure from normal of average temperature (°F.) for the week ending January 29, 1961. This was the coldest week of the month (from [6]).

favoring lower temperatures east of the Rockies. The close relationship of positive height anomaly in the Yukon and negative temperature anomaly in eastern United States is well known [2,3]. The change of half-month temperature anomaly (fig. 5D) shows that cooling occurred over the entire area east of the Continental Divide and was most intense over Illinois and Indiana.

During the latter half of January a 5-day mean High traversed an unusual path from the Great Basin northward along the western slopes of the Rocky Mountains through Alaska. The track of the High center has been plotted on the 15-day mean 700-mb. chart for January 16–30 (fig. 5B), during which period the mean ridge over the Rockies was exceptionally strong. It is noteworthy that the center followed closely the sharp ridge, and the High could be traced clearly on 5-day mean maps (prepared three times a week) from January 14 to February 4.

3. MONTHLY CIRCULATION AND TEMPERATURE PATTERNS

The most intense anomaly of the 30-day mean circulation at 700 mb. was centered in the extensive negative area in the eastern Pacific (fig. 6), associated with southeastward displacement from normal of the Aleutian Low. In the center, about 700 miles south of the Alaskan Peninsula, 700-mb. heights averaged 470 feet below normal and sea level pressures (fig. 7) 20 mb. below normal.

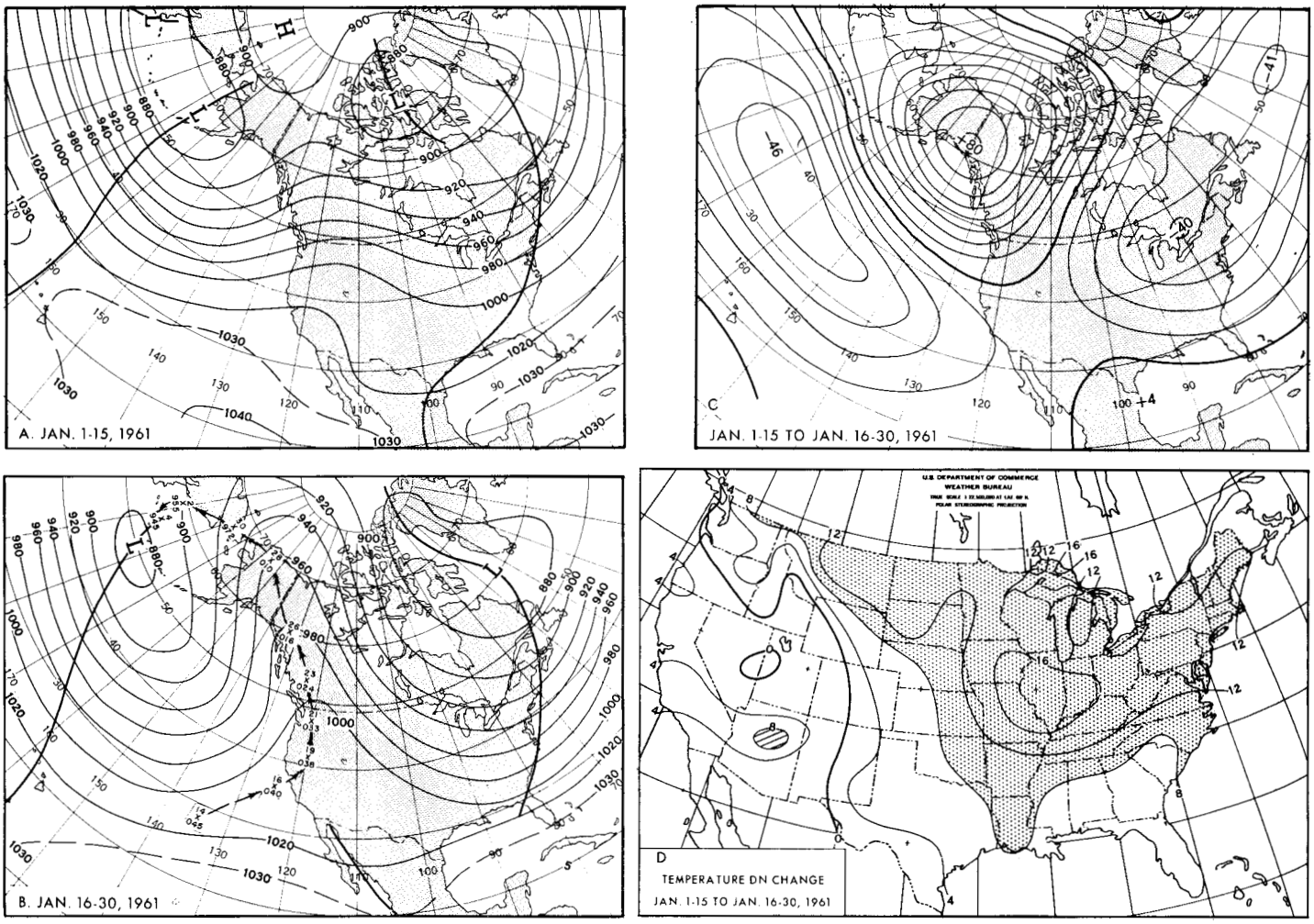


FIGURE 5.—(A) Mean 700-mb. contours (tens of feet) for January 1–15, 1961 and (B) January 16–30, 1961. Note amplification from (A) to (B) and path of a 5-day mean High over western North America from January 14 to February 4 in (B). Middle day of period is plotted above position and central intensity (in tens of feet) below. (C) Changes of 700-mb. height (tens of feet) (January 16–30 minus 1–15). Rises over the Yukon contributed to falling temperature anomalies in the United States shown in (D), the temperature anomaly change (°F.) for same periods as (C).

Progressively lesser anomalies appeared downstream, in the ridge favored by climatology over the northern Rockies, in the trough along the east coast from the Maritime Provinces southward, and in the Azores High.

Blocking, as it is represented by positive height anomalies centered north of negative anomaly centers or channels, occurred in the Davis Strait area and over the East Siberian and Beaufort Seas. The Davis Strait region has been the seat of positive anomaly centers in most Januarys since 1954. Blocking is implicit in the spreading of the mean contours over Europe, though the anomaly pattern there indicates that the condition was neither well-organized nor strong. However, the axis of maximum average wind speed at the 700-mb. level was diverted southward from its usual path into central Europe (fig. 8). Southward displacement also occurred in the eastern Pacific, eastern United States, and western Atlantic Ocean.

A secondary maximum of mean wind speed from the Arctic Basin southward through western Canada marked approximately the principal path of daily Highs (fig. 9A). These Highs were instrumental in transporting cold air into the eastern States in the latter half of the month. During the warm portion, until around the 19th, all the Arctic Highs moved eastward between Hudson Bay and the Great Lakes. Subsequently the Highs plunged southward across the Great Plains and then followed the mean axis of maximum wind speed (fig. 8) eastward into the Atlantic. In spite of the abnormality of the upper-level circulation, it is noteworthy that both of these anticyclone paths are indicated as principal tracks for January by Klein [4].

Although there was considerable variability within the month, temperature anomalies over the contiguous United States (fig. 10) did not change greatly from December. The usual test for persistence (Namias [5]) showed 85

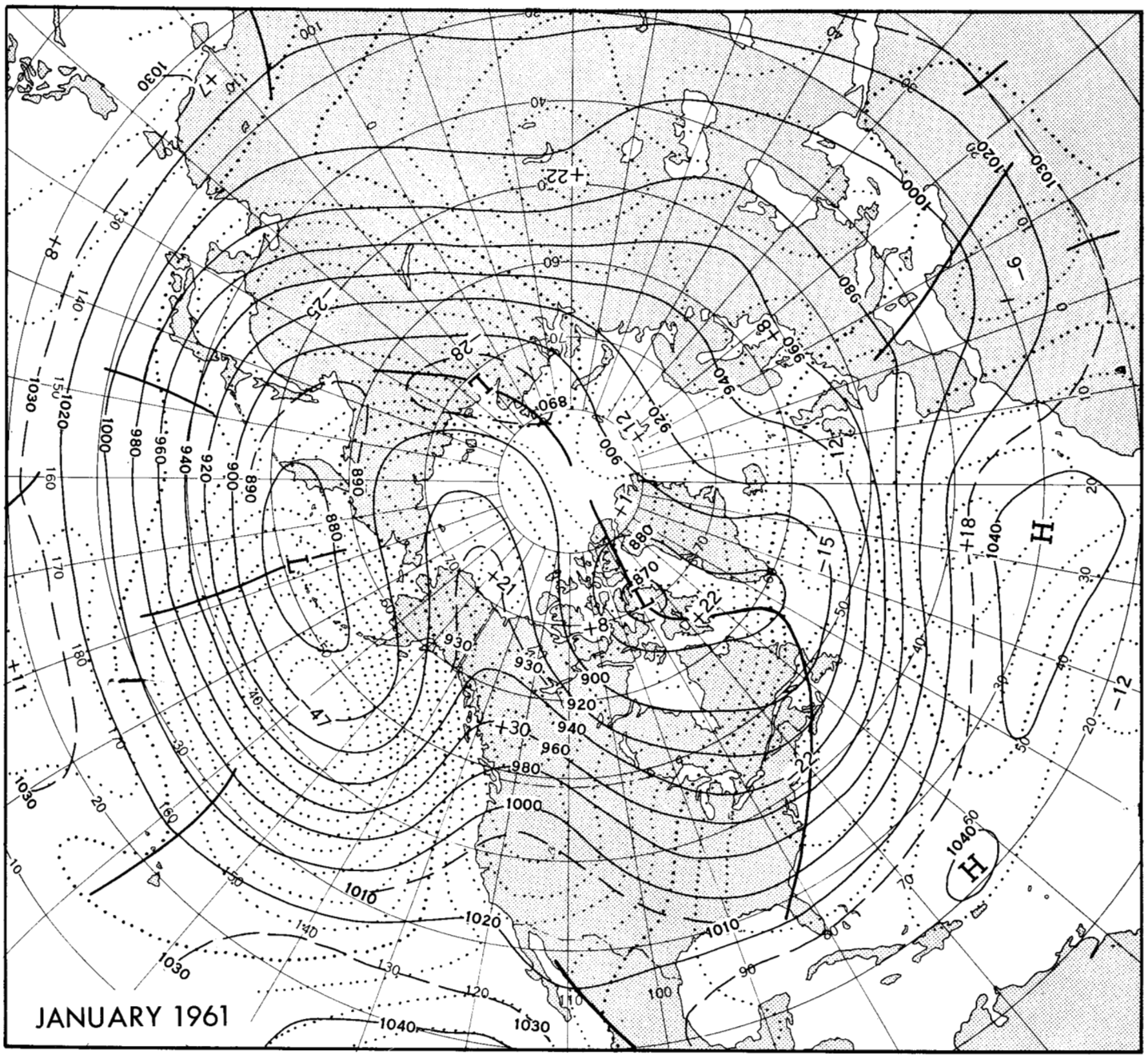


FIGURE 6.—Mean 700-mb. contours (solid) and departures from normal (dotted), both in tens of feet, for January 1961. Greatest anomaly was located in the eastern Pacific. Ridges and troughs were progressively weaker going downstream.

percent zero or one class change (out of five classes), which is high compared to the expected 71 percent. During January temperature persistence was highest over the West and the South, where changes in the circulation (fig. 5C) were not extensive. One new record for January cold was established, at Hartford, Conn., and several new marks were set for warmth in southern California. Stations listing record high averages were Blue Canyon, Burbank, Los Angeles (city office), and San Diego. These stations were in the region of warm downslope winds, locally called Santa Ana, which blow when the Great Basin High is strong at sea level. The mean sea level pressure distribution of January (fig. 7), with pressures 5 mb. higher than normal over the Great Basin, was ideal for the generation of these warm winds. In other western regions temperatures were generally warmer than normal under the influence of the persistent mean ridge.

4. PRECIPITATION

It has been mentioned that the interior of the contiguous United States was extremely dry in January. Figure 11,

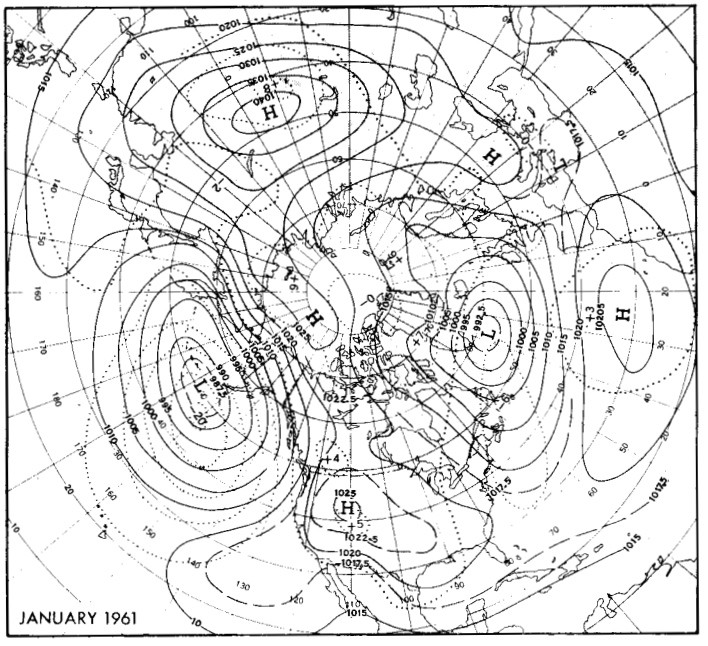


FIGURE 7.—Mean sea level isobars (solid) and departures from normal (dotted), (both in millibars) for January 1961. Intermediate isobars are dashed. Pressures were 20 mb. lower than normal south of Alaska.

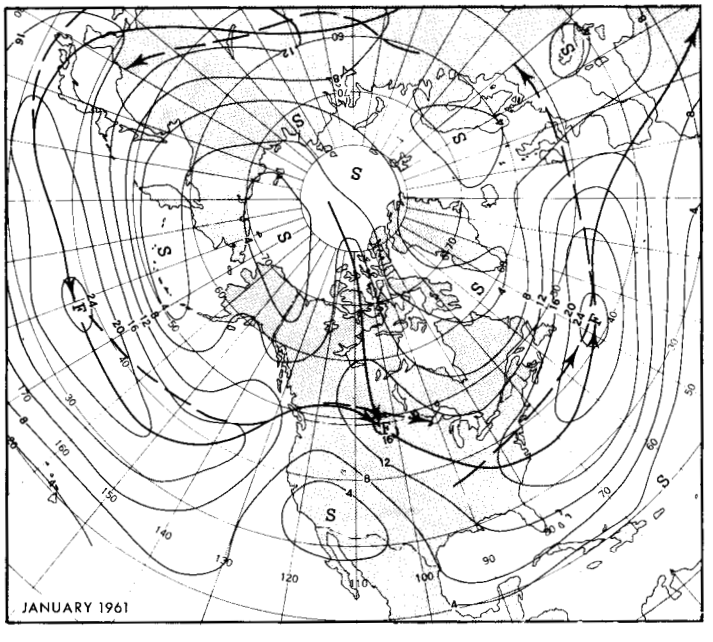


FIGURE 8.—Mean isotachs (in meters per second) of 700-mb. wind speed during January 1961. Solid arrows indicate observed axis of maximum wind speed, and dashed arrows the normal. Secondary maximum approximated principal path of Arctic High from the Polar Basin across western Canada into central United States (fig. 9A).

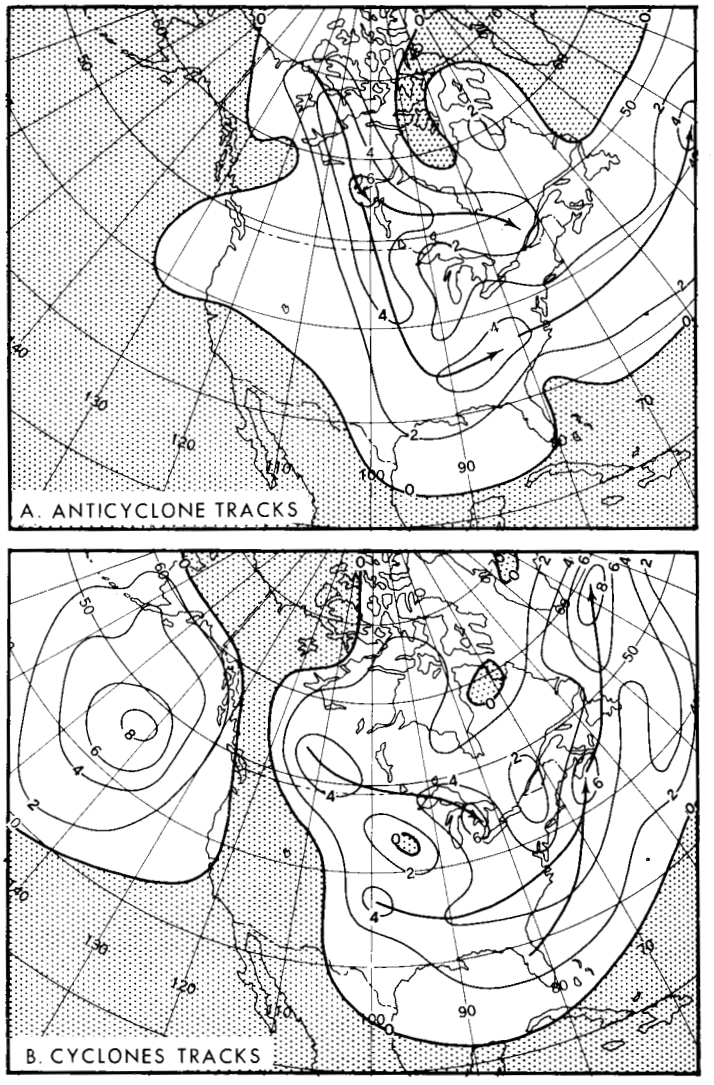


FIGURE 9.—(A) Frequency of daily anticylcone passages and (B) cyclone passages (within equal area boxes of 66,000 nautical mi.^{2}) during January 1961. Arctic Highs were diverted toward James Bay during first 20 days of month, but continued southward through Great Plains thereafter. Areas of zero frequency are shaded.

showing the percent of normal monthly precipitation, illustrates the large extent of the area reporting less than normal amounts. In addition to the broken records of long standing listed in table 1, there were numerous reports of "driest January" for shorter periods. Apparently the strong ridge over western North America precluded extensive upward motion and flow of appreciable moisture from the Gulf of Mexico or Pacific Ocean. Certainly no daily cyclones passed through the ridge at sea level (see fig. 9B). Several Lows of the Alberta type migrated eastward into the Great Lakes region, but Alberta Lows are typically dry.

Another group of sea level cyclones originated in Kansas or the Texas Panhandle. These too were dry initially,

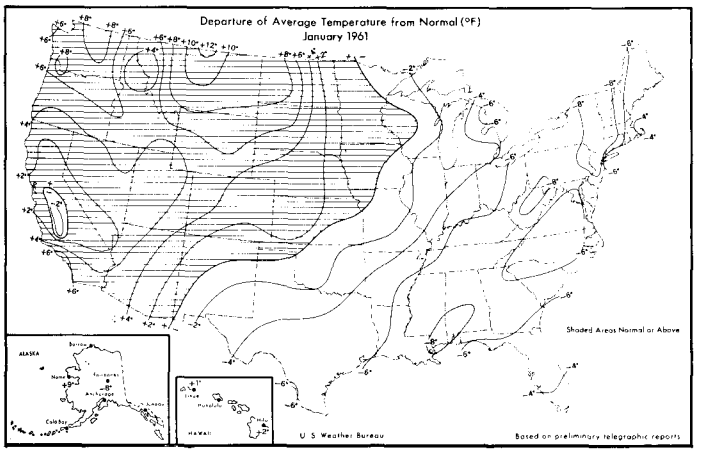


FIGURE 10.—Departure of average temperature (°F.) from normal for January 1961 (from [6]). Hatching indicates areas of above normal temperatures.

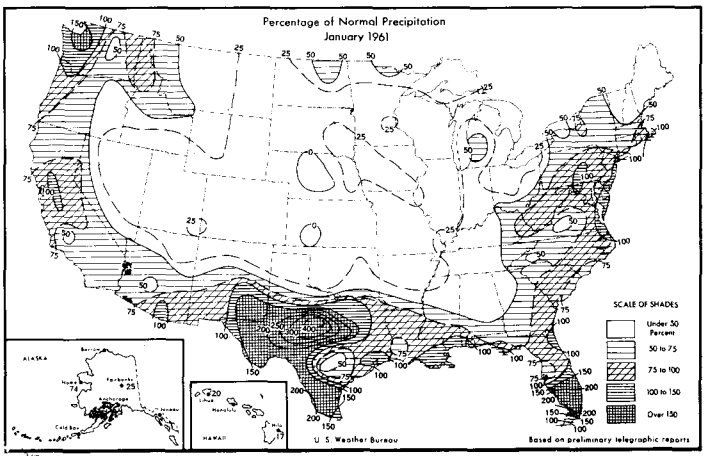


FIGURE 11.—Percentage of normal precipitation for January 1961. The month was extremely dry over most of the interior of the United States (from [6]).

in the lee of the Divide, but produced precipitation farther eastward when moisture entered the systems from the Gulf of Mexico. This group of Lows triggered the intense developments off the Atlantic coast described in section 2. Precipitation totals in the region affected by these storms averaged less than the January normal amounts except for a small area in the central Appalachians and a narrow strip along the coast from Cape Hatteras to Long Island. Snowfall was greater than normal over a larger area. Harrisburg, Pa., reported 34 inches, a new January record. At Akron, Ohio, snowfall was twice the normal, but its water content was very low and total monthly precipation was the lowest on record.

In central Texas precipitation amounts were as much as 400 percent of normal. Abilene and Waco reported the wettest January on record with 3.99 inches and 5.83 inches, respectively. There the precipitation was associated with over-running Gulf air during the passage of upper-level Lows or troughs across the Southwest, none of which was reflected appreciably in the daily sea level pressure patterns over Texas.

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